

Please amend claim 10 as shown in the enclosed marked-up copy.

Please cancel claims ~~11-17~~ without prejudice.

Remarks:

Claims 1-10 remain pending in the application. Claims 11-17 have been canceled. Claim 1 has been amended, and support for the limitation that the rotor be adapted for repetitive rotational movement with a set angular range in response to energization of the coil and be further adapted to be held in a rotational position by a detent torque when said coil is deenergized can be found throughout the application. For example, on page 15, lines 5-24, Applicant discloses how the detent torque maintains the rotor in its rotational position even when the coil is in a deenergization mode. Claim 6 has been amended to more clearly define the groove or cut provided on the magnet. Claim 7 has been amended to more clearly define that the number of polar teeth is N. Claim 10 has been amended to bring it into agreement with amended claim 1. No new matter is added.

I. Amended claim 1 is patentable over the combination of Komatsu (U.S. Patent No. 4,656,381) and Atsumi (U.S. Patent No. 5,113,107) because the Komatsu/Atsumi combination fails to teach or suggest an actuator comprising a rotor "adapted to be held in a rotational position by a detent torque when said coil is deenergized."

In the Office Action dated October 25, 2000, claims 1-5 and 9 were rejected under 35 USC § 103(a) as being unpatentable over Komatsu (U.S. Patent No. 4,656,381) in view of Atsumi (U.S. Patent No. 5,113,107). While recognizing that the Komatsu reference fails to disclose a rotor adapted for repetitive rotational movement within a set angular range, the Office Action contends that the Atsumi reference does disclose a rotor adapted for repetitive rotational movement. However, Applicant respectfully submits that this rejection is not applicable to amended claim 1 because amended claim 1 recites that the rotor is adapted to be held in a rotational position by a detent torque when the coil is deenergized, -- a feature of the claimed invention that the cited references fail to teach or suggest.

A. The Actuator of the Present Invention

Figures 3, 4, and 5 of the application show torque characteristics of the actuator of the present invention. In the figures, the rated torque is the torque generated when the coil is energized at a rated current. The detent torque is the torque generated when the coil is in a deenergization mode. The angle θ is the relative angular difference between the rotor and the stator. Figures 2(a) and 2(b) illustrate the basic rotational characteristics of the rotor in response to coil energization in the direction of I_1 (clockwise rotation) and I_2 (counter-clockwise rotation).

As can be seen in Figure 4 and the accompanying description in the specification (see Application, page 14, line 7 - page 15, line 15), the rotor will carry out repetitive rotational movement within the angular range of θ_2 to θ_1 . If the rotor lies between θ_3 and θ_1 , and the coil is in a deenergization mode, then the detent torque will be positive; hence the rotor is rotated by a torque in the clockwise direction and stopped at the position of θ_1 (and held at that position).

In this state, if current is continued to be passed in an I_2 direction, then the rotor overcomes a positive detent torque and generates a torque in the counterclockwise direction, eventually stopping at the position of θ_2 . If the duration of energization in the I_2 direction is short, and current is cut off before the rotor reaches θ_3 , then the rotor is moved back to the initial position θ_1 by a positive detent torque. If the duration of energization in the I_2 direction is long enough to move the rotor to position θ_2 , and then the coil is deenergized by cutting off the current, then the rotor is maintained at position θ_2 by a negative detent torque. In this state, if the current is switched to the I_1 direction, then the rotor overcomes the negative detent torque and generates a torque in the clockwise direction to go back to position θ_1 .

"Thus according to the present invention, each time the energizing direction of the coil is switched, the rotor carries out repetitive motion in the range defined by θ_2 and θ_1 , and the rotor can be set in a given direction *by making use of detent torque even when the coil is in deenergization mode.*" (See Application, page 15, lines 16-21 (emphasis added)). Because the actuator of the present invention can maintain its rotor position even when the coil is deenergized, "the present invention can be applied to, for example, a camera shutter or the like to always hold the shutter closed by the detent torque, open the shutter only for a required period of time by energizing a coil only when taking a photograph (for exposure), then close the shutter by inverse energization. Thereafter, the energization can be cut off to maintain the shutter in the closed state by the detent torque." (See Application, page 15, line 25 - page 16, line 6). This feature is extremely effective to achieve power saving because current is not required to keep the shutter closed.

B. The Shortcomings of the Atsumi and Komatsu References

The Atsumi reference, however, fails to teach or suggest that the actuator rotor be held in position by a detent torque when the stator coil is deenergized. In fact, the operation of the Atsumi rotary actuator only contemplates energization of the stator coil. The operation of the Atsumi actuator is described in Atsumi at column 4, lines 22-51. In Atsumi, when the coil is energized, a magnetomotive force causes the rotary shaft 41 and lever 9 to rotate counterclockwise. This rotational movement stops when one of the tabs 45 or 46 of the lever/rotary shaft abuts against a stopper 7. When the stator coil is energized counterclockwise, the rotary shaft and lever rotate clockwise until one of the tabs abuts the stopper.

"Thus, the rotor 5 is rotated according to the direction that the stator coil 14 is energized." (See Atsumi, column 4, lines 50-51). *Atsumi never discusses rotor movement or detent torque when the coil is in a deenergization mode.*

Because the Atsumi reference is silent with respect to rotor behavior when the coil is deenergized, the Atsumi reference utterly fails to teach or suggest a rotor adapted "to maintain its rotational position by means of a detent torque when said coil is deenergized", as recited by claim 1. Thus, the rotary actuator disclosed in Atsumi would be ineffective to provide reduced power consumption *because Atsumi requires coil energization to keep the rotor properly positioned.* Therefore, not only is Applicant's claimed actuator different from that of Atsumi, but Applicant's actuator also represents a significant improvement over the Atsumi actuator because of the power savings that Applicant's actuator provides.

Komatsu similarly fails to disclose a rotor adapted to be held in its rotational position by a detent torque when the coil is deenergized. Because Komatsu fails to address a rotor adapted for repetitive rotational movement between an angular range (as acknowledged by the Examiner), Komatsu therefore also fails to address using a detent torque to hold the rotor in a given position within that angular range.

Therefore, Applicant submits that amended claim 1 is patentable over the cited references, and respectfully requests reconsideration of the obviousness rejection. To establish prima facie obviousness of a claimed invention, all claim limitations must be taught or suggested by the prior art. *In re Royka*, 180 USPQ 580 (CCPA 1974). The Komatsu and Atsumi references fail to teach or suggest an important limitation of claim 1, namely that the rotor is adapted to be held in a rotational position by a detent torque when the coil is deenergized. Applicant further submits that claims 2-10 which depend from claim 1 are also patentable.

II. Claim 6 is patentable over the combination of Komatsu, Atsumi, and Yamaguchi (U.S. Patent No. 5,373,207) because a person of ordinary skill in the art would not be motivated by the Yamaguchi reference to use an imbalanced magnet in an actuator.

Claim 6 recites that "a groove or a cut for destroying magnetic balance is provided in an axial direction on a central portion of either a south pole or north pole of said magnet." As disclosed in the application on page 17, line 10 through page 18, line 13, such a groove or cut will produce an increase in the repetitive motion range.

The Office Action rejected claim 6 as being obvious in view of the combination of Komatsu and Atsumi and further in view of Yamaguchi. Yamaguchi discloses a vibrator motor having an eccentrically-shaped rotor magnet (see Yamaguchi, Figures 2, 7, 9 -- the magnet has an arcuate/sectorial shape). Yamaguchi further discloses that this eccentrically-shaped magnet "causes vibrations when the rotor is rotated" and allows for the vibrator to vibrate without using eccentrically weighted output shafts,

etc. (See Yamaguchi, column 2, lines 36-55). The Office Action contends that claim 6 is rendered obvious because it would be obvious to modify the combined Komatsu/Atsumi device with the eccentrically-shaped Yamaguchi magnet to produce a motor that does not require an eccentrically-weighted output shaft or an external eccentric weight.

However, Applicant respectfully submits that a person of ordinary skill in the art would not be motivated by the Yamaguchi reference to use an eccentrically-shaped magnet in the rotor of an actuator. Yamaguchi is addressed to vibrator motors, not actuators. In a vibrator motor, it is desirable to produce vibrations. However, vibrations are not a desirable result in actuators. Having no desire to increase the vibrations caused by the rotor, a person working with an actuator would not look to Yamaguchi for guidance in designing a rotor magnet.

The inventors herein found that providing a groove or cut in the rotor magnet increases the repetitive rotational range of the rotor, as more fully explained on pages 17 and 18 of the application. The Yamaguchi reference does not teach or suggest that this desirable result will flow from using an imbalanced magnet. Yamaguchi only teaches that the use of an imbalanced magnet will produce the undesirable result of vibration.

"[T]he Examiner must show reasons that the skilled artisan, confronted with the same problems as the inventor and with no knowledge of the claimed invention, would select the elements from the cited prior art references for combination in the manner claimed." In re Rouffet, 47 USPQ2d 1453, 1458 (Fed. Cir. 1998) (*see also* Lindemann Maschinenfabrik GmbH v. American Hoist & Derrick Co., 221 USPQ 481, 488-89 (Fed. Cir. 1984) (the initial obviousness inquiry must be gauged from the vantage point of a person attacking the problem solved by the invention, and prior art that does not suggest the claimed solution to a problem should not be used to render that claimed solution obvious); In re Benno, 226 USPQ 683, 687 (Fed. Cir. 1985) (a reference should be dismissed when that reference does not even hint at the problem that the appellants sought to solve)). The problem solved by the inventors herein is that of increasing the repetitive rotational range of the actuator rotor through the use of an imbalanced magnet. A reference teaching that an imbalanced magnet will cause vibrations in a vibrator motor (a result not desirable in an actuator) would not lead one of ordinary skill in the art to incorporate an imbalanced magnet in the rotor of an actuator. Therefore, the rejection of claim 6 using Yamaguchi as a reference is improper, and Applicant respectfully requests that the rejection be withdrawn.

III. Claim 7 is patentable over the combination of Komatsu, Atsumi, and Haydon (U.S. Patent No. 4,274,026) because a person of ordinary skill in the art would not be motivated by the Haydon reference to configure N polar teeth to stay within a range of $220/N$ to $260/N$ degrees at central angle.

Claim 7 recites that the "extensions of said polar teeth in a circumferential direction are all the same and stay within a range of $220/N$ to $260/N$ degrees at central angle." As disclosed on page 18, line 17 through p. 19, line 14 of the application, the inventors herein found that such a configuration of polar teeth produces an increase in the repetitive rotational range of the actuator.

The Office Action rejected claim 7 as being an obvious combination of the Komatsu, Atsumi, and Haydon references. The Haydon reference is cited for disclosing that two stator pole teeth subtending an angle of between 120 and 160 degrees with respect to the axis of rotation of the rotor provides higher output torque for the motor and an increased magnetic saturation level for the stator poles, which thereby allows the motor to be power driven at input voltages substantially in excess of the rated voltage. (See Haydon, column 9, lines 4-19). From this statement in Haydon, the Examiner contends that it would be obvious to combine the Haydon pole teeth configuration with the Komatsu/Atsumi actuator to produce the actuator of claim 7.

However, Applicant submits that a person of ordinary skill in the art seeking to improve the range of repetitive motion in an actuator would not look to the Haydon reference for guidance. Haydon deals with a rotating machine that is not configured for repetitive rotational movement. Haydon therefore provides no teaching with respect to increasing the repetitive rotational range of an actuator, and a person seeking to increase the repetitive rotational range of an actuator would not learn how to do so upon reading the Haydon reference. Haydon merely teaches that a higher output torque can be achieved in a rotating machine when the stator poles have widths that subtend a central angle of 120 to 160 degrees.

As explained above, for an obviousness rejection to be valid, "the Examiner must show reasons that the skilled artisan, confronted with the same problems as the inventor and with no knowledge of the claimed invention, would select the elements from the cited prior art references for combination in the manner claimed." In re Rouffet, 47 USPQ2d 1453, 1458 (Fed. Cir. 1998). In this case, Applicant submits that the obviousness rejection is improper because a skilled artisan confronted with the problem of increasing the repetitive rotational range of an actuator would not choose to follow the teachings of Haydon, which relate to increasing the output torque of a rotating machine. Applicant therefore respectfully requests reconsideration of the rejection of claim 7.

IV. Claim 10 is patentable over the combination of Komatsu, Atsumi, and Horst (U.S. Patent No. 5,122,697) because a person of ordinary skill in the art would not be motivated by the Horst reference to configure the actuator with the claimed detent torque/rated torque relationship.

Claim 10 recites that the actuator be configured with the following relationship between detent torque T_d and rated torque T_{rate} : $T_{rate}/4 \leq T_d \leq 3T_{rate}/4$. As is explained by the inventors in the application on page 22, line 22 through page 23, line 15, the repetitive rotational range of the actuator tends to be narrower as the detent torque approaches the rated torque (especially so if $T_d > 3T_{rate}/4$). Also, if the detent torque is too small relative to the rated torque, the rotor cannot be held in a given position when the coil is deenergized. Thus, a balance must be struck where a satisfactory range of repetitive rotation is provided while a sufficient amount of detent torque still exists to hold the rotor at a given position during deenergization. The inventors found that the relationship expressed in claim 10 achieves such a balance.

The Office Action rejected claim 10 as being an obvious combination of Komatsu, Atsumi, and Horst. The Horst reference is cited for disclosing the lower bound of the T_d/T_{rate} relationship, wherein $T_{rate}/4 = T_d$ (see Horst, Figure 2). From this disclosure, the Examiner contends that it would be obvious to have the T_d/T_{rate} relationship of claim 10 for the purpose of providing rotor torque when the coil-excited reluctance torque is zero or negligible.

However, according to Horst, its detent torque/coil-excited torque ratio is highly dependent upon "the strength and placement of magnet 23 and the configuration of the rotor 15." (see Horst, column 5, lines 7-10). Thus, the Horst relationship is specific to its own motor configuration. It is therefore important to note that the variable reluctance motor of Horst is markedly different than the actuator of the present invention. The Horst reluctance motor does not incorporate the magnet within the rotor; rather the Horst reluctance motor has a separate magnet mounted on one of the stator teeth. The actuator of the present invention, however, incorporates the magnet in the rotor itself. Thus, when Horst teaches that its detent torque/coil-excited torque relationship is unique to its own magnet and rotor configuration, Horst fails to provide a teaching with respect to torque relationships that is applicable to an entirely different rotor/magnet configuration.

Compounding the inapplicability of the Horst reference to the actuator of the present invention is the fact that the Horst motor does not provide repetitive rotational movement within a set angular range. Thus, not only are the structural properties of Horst different than that of the present invention, but the functionality desired for a reluctance motor is not the same as the functionality desired for an actuator (a broad repetitive rotational range is desired with the actuator). In fact, the Horst reference is utterly silent with respect to how one can improve the repetitive rotational range of actuators.

Therefore, a person seeking to improve the range of repetitive rotational movement in an actuator would not be guided by the Horst reference to use the T_d/T_{rate} relationship of claim 10 because of the marked differences between the Horst motor and the actuator of the present invention, and because of Horst's own statement that its torque relationship is unique to its own rotor/magnet configuration. Moreover, while the inventors herein found that keeping the detent torque too small with respect to the rated torque results in the inability of the rotor to maintain a given position during deenergization (see Application, page 23, lines 2-5), Horst teaches that "the magnet detent torque is of a much smaller absolute magnitude than the coil excited torque." (see Horst, column 5, lines 5-7). Such a teaching would lead on of ordinary skill in the art away from the T_d/T_{rate} relationship of claim 10 because it would discourage a skilled person from approaching the upper bound of the inventors' claimed relationship.

Applicant therefore submits that claim 10 is nonobvious with respect to the Komatsu/Atsumi/Horst combination, and respectfully requests reconsideration of the rejection.

V. Conclusion

For the foregoing reasons, Applicant submits that the claims are patentable over the cited references. Favorable action is respectfully requested.

Respectfully submitted,



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